USE OF SCAPS SUITE OF TOOLS TO RAPIDLY DELINEATE A LARGE MTBE PLUME

SCAPS BENEFITS:

1) Saves significant amounts of money and time;
2) Enables users to rapidly map action level iso-concentration contours;
3) Facilitates rapid site closure;
4) Leads to decision making flexibility while equipment is still in the field.

INTRODUCTION:

Use of the Navy Site Characterization and Analysis Penetrometer System (SCAPS) at hazardous chemical release sites has led to significant government savings over the past three years. While SCAPS is best known for its ability to rapidly detect petroleum hydrocarbons using laser spectroscopy, the system is also equipped with sampling capabilities which can lead to expedited site characterization at petroleum and non-petroleum sites. When used in conjunction with on-site or near term analytical laboratories, the SCAPS suite of tools can lead to significant cost savings, time savings and many other benefits for remedial project managers (RPMs).

At the request of RPMs working for the Environmental Department at the Naval Construction Batallion Center (Port Hueneme, California), the Public Works Center (PWC) San Diego SCAPS team was used to delineate the downgradient extent of a dissolved methyl tert butyl ether (MTBE) plume in an unconfined aquifer beneath the activity. Records indicated that approximately 11,000 gallons (42 cubic meters) of leaded and unleaded petroleum products were released from underground storage tank lines of a gasoline station between September 1984 and March 1985. MTBE, which has been used as a gasoline additive since the late 1970s to reduce toxic air emissions associated with fuel combustion, was identified in the downgradient monitoring wells present at the site in 1996. MTBE is poorly degraded, highly mobile, toxic and potentially carcinogenic. Future MTBE action levels for California are anticipated to be 35 parts per billion (ppb).

The goal of the investigation was to select appropriate monitoring well installation locations in order to evaluate whether the plume posed a risk to potential receptors (drainage canals and other surface water bodies). To accomplish this goal, SCAPS was used to help delineate the MTBE plume, prepare an iso-concentration map which displays the 35 ppb contour, identify the optimal monitoring locations, and install 3-4” micro-wells in these areas. Fifteen field days were required to collect a total of 44 water samples and install 11 micro-wells. Approximately 33 acres of the MTBE plume (in map view) were delineated (to the satisfaction of the regulators) in

a rapid and cost-effective manner. In addition, a site closure strategy was agreed upon by the customer and regulators less than one month after completion of the field efforts.

METHOD DESCRIPTION:

Water samples were collected using a ConeSipper® attachment (Figure 1) and analyzed in near real-time using an off-site gas chromatograph with a flame ionization detector. Analytical turn-around time was approximately 90 minutes from the time the samples were collected. Sample locations were selected based on the near real-time results, leading to a dynamic, flexible, work plan. A site map was continually updated using a global positioning system (GPS) and a version of Autocad available on the SCAPS unit.

FIGURE 1. ConeSipper® SCAPS attachment and pneumatic valving system used to collect water and soil gas samples.

Optimum perimeter and sentry well locations were based on the ConeSipper® sample results. Wells were installed using a Powerpunch micro-well system on the SCAPS unit. Wells were customized based on the future monitoring requirements of regulatory personnel. For instance, it was desired that shallow and deep samples would be required to monitor the chemical stratification of the central portion of the dissolved MTBE plume. Therefore, six wells consist of one foot (0.3 meter) long screens at specific depths to isolate the portions of the plume in question. The other five wells were constructed with solid polyvinyl chloride casing for the top five feet (1.5 meters) connected to twenty feet (6.1 meters) of screen section.

Regulators and customers were in continuous communication (via fax and phone) with the SCAPS crew throughout the entire plume investigation. As a result, the regulators were involved

in the decision-making processes. A final tabulation of the ConeSipper® results and a map depicting these values were presented to the customer and regulators prior to leaving the site. This enabled the customer to quickly decide upon their next course of action.

SITE DESCRIPTION:

Roughly 11,000 gallons (42 cubic meters) of regular and unleaded gasoline were released from underground storage tank lines at a gasoline station site between September 1984 and March 1985. Prior to this field effort, 42 two and four inch diameter monitoring wells had been installed at the site. The measured gasoline portion of the plume extended close to 1080 feet (329.2 meters) downgradient of the source area (approximately 9.4 acres in map view area), while MTBE concentrations as high as 16,000 ppb were identified in the most downgradient wells (located approximately 1500 feet, or 457 meters, downgradient from the source).

The semi-perched aquifer zone consists of fluvial-deltaic sediments approximately 25 feet (4.6 meters) thick in the vicinity of the site. The uppermost silty sands grade into more sand and silty sand at depths ranging from 7.5 to 25 feet (2.3 to 4.6 meters) below ground surface (bgs). The unconfined water table ranges 8.5 to 12 feet (2.6 to 3.7 meters) bgs. Therefore, the saturated aquifer thickness is approximately 15 feet (4.6 meters). Hydraulic conductivity ranges from 0.2×10^{-3} to 1.4×10^{-3} meters/second. The average linear ground water velocity in the unconfined aquifer ranges from approximately 230 to 1450 feet (70 to 440 meters) per year, assuming a porosity of 0.3.

RESULTS AND DISCUSSION:

During the 15 field days, approximately 3000 feet of the downgradient extent of the MTBE plume (including the most downgradient edge) was delineated using an expedited site characterization approach which included SCAPS applications. The amount of area covered during the investigation extended approximately 45 acres. The SCAPS team discovered that the dissolved MTBE plume extends 33 acres in map view area. Prior to leaving the field, the SCAPS team provided the customer with analytical results tables and a digitized map which depicted the plume extent, analytical results, and all sampling and well installation locations (which were surveyed using GPS). A final report was submitted to the customer within one month.

The entire MTBE plume, based on SCAPS ground water samples and monitoring well samples, extends approximately 4100 feet (1250 meters) in length and approximately 500 feet (150 meters) in width through the widest segment. Based on the findings, it appears that MTBE can migrate relatively long distances with a relatively small amount of dispersion. Assuming that MTBE was first introduced into the aquifer in 1984, one can calculate the conservative (most rapid) linear contaminant velocity to be approximately 342 feet (104 meters) per year for this site. This is within the range of calculated ground water flow based on aquifer tests (230 to 1450 feet per year or 70 to 440 meters per year).

Given these relatively rapid contaminant migration rates and slow natural degradation rates, it is recommended that expedited site characterization methods (such as the SCAPS assemblage of applications) be utilized for every site suspected of MTBE contamination. In addition, inclusion of the customer and the regulator in the decision-making process will be conducive to achieving project goals. Benefits of proceeding in this manner include the following:

1) Saves significant amounts of money and time;
2) Enables users to rapidly map compliance level iso-concentration contours;
3) Facilitates rapid site closure;
4) Leads to decision making flexibility while equipment is still in the field;
5) Investigators, customers, and regulators can make critical decisions in near real-time;
6) Reduces worker exposure risk;
7) Reduces the amount of industrial derived waste (IDW) for investigation and installation efforts;
8) Reduces the amount of IDW for future monitoring events;
9) Optimizes monitoring well placement locations;
10) Well design can be customized based on SCAPS soil classification;
11) Interactive decision making (with regulator input) is conducive to creating a productive working relationship while avoiding future misunderstandings.

COST/TIME AVOIDANCE:

The following section compares the costs of using the SCAPS assemblage of site characterization tools with the costs associated with using a conventional approach for the dissolved MTBE plume characterization effort described above. Since SCAPS expedited site characterization activities are much different than those associated with a conventional approach, assumptions and activity descriptions are presented. Disadvantages of using a conventional approach for this site are also discussed.

SCAPS Approach (using the SCAPS assemblage of tools):
The SCAPS team charged $83,250 for the 15 field days required to complete the project. This cost included a pre-deployment site survey, a work plan, a health and safety plan, drilling permits, equipment and personnel mobilization, personnel housing and per diem, geophysical surveys to "clear" for utilities, collection and analysis of 44 ConeSipper® samples, 9 ConeSipper® duplicates, 9 equipment blanks, installation of 11 customized micro-wells (with vaults and concrete seals), near real-time mapping using GPS and Autocad, near real-time analytical results, a complete map-view delineation of the MTBE plume (4100' X 500'), demobilization, a draft final report, and a final report. The activity contracted an outside lab to run the confirmation samples during the final phase at a cost of $3000. Development and sampling of the eleven micro-wells required approximately two days of effort at a cost of approximately $1000. Analytical laboratory costs for the initial round of micro-well water samples totaled $1100. Only seven fifty-five gallon drums of equipment decontamination rinse water were generated for the entire project. These can be disposed of for approximately $200 (7 drums X 55 gals @ $.50 per gallon of liquid waste). In addition, the SCAPS team provided analytical results tables and an up-to-date site map to the customer prior to demobilizing,

enabling the customer and regulators to make critical decisions as soon as possible. During the investigation, the SCAPS crew obtained approval from the customer and regulators for optimal sampling and well placement locations by maintaining communication via fax and phone - effectively generating a dynamic work plan which was tailored to the site conditions as the investigation proceeded. By the time the final report was completed, the customer and regulator agreed to a monitoring plan which would lead to site closure upon demonstration of plume stability.
Total Costs/Timing: $88,550; 15 field days; final report submitted one month from final field day.

Conventional Approach: (Four inch diameter monitoring well installation and one round of sampling):
The probability is that there will be an initial deployment and at least five additional mobilizations to determine the extent of the MTBE plume using a conventional approach. This is based on the assumption that the 3000 longitudinal feet covered by the SCAPS approach would be broken into six 500 foot increments (longitudinal) - for a total of six deployments. Assuming that ten monitoring wells are used for each deployment (for a total of 60 wells) at a cost of approximately $2500 each, the costs for well installation efforts alone will be $150,000. Approximately one drum of solid IDW per well would be generated at a disposal cost of $6000 total (60 wells @ $100 per solid waste IDW drum). If soil samples were collected and analyzed during the well-installation efforts, additional costs would run $30,000 (5 samples per well @ $100 per sample). The costs for well development and the initial round of water sampling for all 60 monitoring wells would total $9,000 (3 hours per well @ $50 per hour). Analytical costs for the first round of fluid samples would be $6000. Costs for disposal of liquid IDW would be approximately $3,300 (2 drums per well X 55 gals @ $.50 per gallon of liquid waste). The reporting and consultation fee for this effort would run $50,000 minimum and could cost as high as $150,000.
Total Costs/Timing: $254,300 - $354,300; 40 field days; six interim reports; final report submitted at least one year from completion date for the initial field effort.

Disadvantages of using the conventional approach for this project:

1) the work plan is not flexible from a field operations standpoint;
2) initial costs for the conventional approach would be two to four times higher than the SCAPS approach;
3) investigators would not know if wells are in correct locations until after analytical results are obtained (typically a two week turnaround time);
4) numerous additional wells would be installed in places which would not be cost-effective for the long-term, rendering future monitoring costs excessive and unnecessary;
5) significant amounts of IDW (180 drums for this example) would need to be handled;
6) duration of the investigation would be at least one year; and
7) at least four meetings with regulators would be expected.

POINTS OF CONTACT:

POCs for these efforts include: NFESC (DSN 551-2669), (DSN 551-1299), CBC Environmental (DSN 551-2105), PWC San Diego (619-556-9506).
For scheduling SCAPS into your process, contact PWC San Diego (619-556-9506), or PWC Jacksonville (904-772-4548, x8312).